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मानक

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“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 4989 (2006): Foam Concentrate for producing mechanical foam for fire fighting - Specification (Amalgamating IS 4989 (Part 1):1985, (Part 2) : 1984, (Part 3):1987 [CED 22: Fire Fighting])



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

आग बुझाने के लिए यांत्रिक झाग बनाने
का झाग सांद्र — विशिष्टि

(तीसरा पुनरीक्षण)

Indian Standard

FOAM CONCENTRATE FOR PRODUCING
MECHANICAL FOAM FOR FIRE FIGHTING —
SPECIFICATION

(*Third Revision*)

ICS 13.220.10; 71.080

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Fire Fighting Sectional Committee had been approved by the Civil Engineering Division Council.

Foam is a homogeneous mass of tiny air or gas filled in bubbles of low specific gravity which when applied in correct manner and in sufficient quantity, form a compact fluid and stable blanket which is capable of floating on the surface of flammable liquids and preventing emission of flammable vapours. It is produced by mechanically mixing a gas or air to a solution of a foam compound (concentrate) in water. This standard covers the foam compound in the form of a homogeneous liquid, free from suspended matter and visible impurities used for the production of fire fighting foam which is produced by mechanical aeration of water foam concentrate solution.

The foam produced from the concentrates in this standard are of low expansion (up to 20 times). The low expansion foam concentrates are of the following types:

- a) *Protein foam (PF)* — A foam concentrate that has a hydrolyzed protein base with stabilizing additives suitable for Class A and B fires.
- b) *Aqueous film forming foam (AFFF)* — A foam concentrate that has a fluorinated surfactant with stabilizing additive and synthetic surfactants foaming agents for Class A and B fires.
- c) *Film forming fluoro-protein foam (FFFP)* — A foam concentrate that is protein base with one or more fluorinated surfactant additives for Class A and B fires.
- d) *Synthetic foam¹⁾* — A non-fluoro surfactant base concentrate non-hydrolyzed protein suitable only for Class A fire.

The earlier version of this standard was existing in four parts. This standard amalgamates first three parts, namely, Part 1 Protein foam concentrate, Part 2 Aqueous film forming foam (AFFF) and Part 3 Fluoro-protein foam. The purpose of all the three types is same, that is, for use in Fire Extinguishing agent for Class 'A' and 'B' flammable liquid (Hydrocarbons) fires. Alcohol resistant foam which forms Part 4 of IS 4989, is not covered in this standard. Chemical foam produced by mixing of sodium bicarbonate and aluminium sulphate with stabilizer has already been discontinued from fire fighting foams and declared an obsolete technology.

Other types of foams are medium expansion and high expansion (20 - 200 and 200 - 1 000 expansions) are also excluded from this standard as their principle for foaming method of use and application in fire protection also differs appreciably.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of specified value in this standard.

¹⁾ This can be also medium and high expansion.

Indian Standard

FOAM CONCENTRATE FOR PRODUCING MECHANICAL FOAM FOR FIRE FIGHTING — SPECIFICATION (Third Revision)

1 SCOPE

1.1 This combined standard for fire fighting foams lays down requirement in respect of physical, chemical properties and performance over fires of standard fuel, for which these foams are formulated. With the invent of new, improved formulations and improved test methods, all latest formulations and test methods are introduced through this standard. This standard also lays down requirement for packaging and storage.

The foam concentrate covered in this standard shall be of the following types:

- a) *Type 3* — To be used with 97 percent water and 3 percent concentrates,
- b) *Type 6* — To be used with 94 percent water and 6 percent concentrates, and
- c) *Type 1* — To be used with 99 percent water and 1 percent concentrate.

1.2 All the above types of foam concentrates are suitable only for top application. A special requirement can be put separately for base injection system for storage tanks.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	Title
5 : 1994	Colours for ready mixed paints and enamels
123 : 1962	Specification for ready mixed paint, brushing, finishing, semi-gloss, for general purposes, to Indian Standard colours (<i>revised</i>)
554 : 1999	Pipe threads where pressure-tight joints are made on threads —

IS No.

Title

	Dimensions, tolerances and designation (<i>fourth revision</i>)
1206 (Part 3) : 1978	Determination of viscosity: Part 3 Kinematic viscosity
1783 : 1993	Drums, large, fixed ends — Specification
2552 : 1989	Steel drums (galvanized and ungalvanized) (<i>third revision</i>)
2932 : 1975	Enamel exterior (a) undercoating, (b) finishing (<i>second revision</i>)
4309 : 1979	Method of measurement on direct reading pH meters (<i>first revision</i>)
4905 : 1968	Method for random sampling
4989 (Part 4) : 2003	Multipurpose aqueous film forming foam liquid concentrate for extinguishing hydrocarbon and polar solvent fires — Specification
7959 : 1987	Specification for polyethylene containers for foam compounds (<i>first revision</i>)

3 REQUIREMENTS

3.1 On visual examination of foam concentrate liquid shall not show any sedimentation or stratification, contained in a covered glass beaker for 24 h at a temperature of $27 \pm 5^\circ\text{C}$ (One cycle). The concentrate also shall not show such sedimentation/stratification after freezing and thawing at -5°C to $27 \pm 5^\circ\text{C}$.

3.2 General

Protein foam and Film forming fluoro protein foam are dark brown or redish brown colour liquids with some offensive odour. The AFFF and Synthetic Class A foams are amber colour clear transparent liquids with no offensive odour.

3.3 Characteristics

The foam concentrates shall conform to physical, chemical and fire performance requirements indicated in Tables 1 and 2 respectively against them when tested in accordance with method specified against each.

NOTES

- 1 The tests described in Annex K are more expensive and time consuming than the other tests of this standard. It is recommended that they are carried out at the end of the test programme, so as to avoid the expense of unnecessary testing of foam concentrates which do not comply in other respects.
- 2 Method of generating foam shall be as per Annex G.

4 PACKING

4.1 Foam concentrate shall be packed in polyethylene HDPE containers conforming to IS 7959 or suitable polythelene container of specification as agreed to between the purchaser and the supplier.

4.2 In addition to above ungalvanized mild steel drums for Protein foam and FFFP shall conform to Grade A2 or B2 of IS 2552 of capacity 20 l or as specified. The closure shall consist of 75 or 100 mm according to the provision given in this standard. The mild steel barrels of capacity 200 l shall conform to IS 1783. Internal surface may be left in natural finish free from rust. The external surface of drums and barrels shall be painted with suitable primer (*see* IS 123) and then painted fire red or post office red conforming to shade No. 536 or 538 of IS 5. The paint shall conform to IS 2932.

5 STORAGE

5.1 The storage place shall be free from dampness and shall be well ventilated and the container shall not be directly exposed to the sun rays.

5.2 The polyethylene jerry cans shall be preferably stacked in single layers and shall not exceed more than 2 layers.

5.3 For bulk storage, the recommended storage container should be made of stainless steel (SS 304) or as per foam manufacturer's recommendation.

6 MARKING

6.1 Each container shall be legibly and indelibly marked with the following information:

- a) Manufacturer's name and trade-mark, if any;
- b) To be written:
 - PF — For Protein foam concentrate for fire fighting
 - FFFP — For Film forming fluoro-protein foam concentrate for fire fighting
 - AFFF — For Aqueous film forming foam for fire fighting
 - SF — For Synthetic foam Class A for fire fighting
 - And Type 1/Type 3/Type 6 as applicable;
- c) Foam compatible with sea water;

- d) Quantity in litres;
- e) Month and year of manufacture and production batch No;
- f) Net and gross mass in kg;
- g) Do not store in direct sunrays; and
- j) Freeze protected foam storage temperature (up to -20°C)

6.2 BIS Certification Marking

The product may also be marked with the Standard Mark.

6.2.1 The use of Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from Bureau of Indian Standards.

7 FUEL FOR FIRE PERFORMANCE TESTING

Fuel shall be *n*-heptane and its certain mixture called commercial heptane with the following specification shall be used:

- Distillation range 84° to 105°C
- Maximum difference between initial and final b.p. shall not exceed 10°C
- Density/sp. gr. 0.70 to 0.80 at 27 ± 5°C

8 TYPE TEST

8.1 Conditioning and fire performance test shall be considered as type test and should be carried out at an interval specified in the scheme of testing.

9 SAMPLING OF THE FOAM COMPOUND CONCENTRATE

9.1 The number of filled containers to be sampled from each batch for ascertaining conformity shall be in accordance with following table:

Scale of Sampling	
Total Number of Filled Containers from Each Batch	Number of Containers to be Selected
Up to 100	5
101 to 200	10
201 and above	15

9.2 The containers shall be selected at random from each batch. To ensure the randomness of selection, method given in IS 4905 may be adopted. The equal amount of samples collected from each selected container should be mixed to make a composite sample to carry out the single conformity test.

**Table 1 Chemical and Physical Properties at $27 \pm 5^\circ\text{C}$
Both Original and Aged Sample
(Clause 3.3)**

Sl No.	Property	Protein	Film Forming Fluoro Protein	AFFF	Synthetic (Class A)	Test Method
		3% and 6%	3% and 6%	3% and 6%	1%	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	pH	6 - 7.5	6 - 7.5	6.5 - 8.5	6.5 - 7.5	Annex A
ii)	Specific gravity	1.13 - 1.18	1 - 1.15	1 - 1.12	1 - 1.12	Annex B
iii)	Miscibility with water	Miscible (Shall pass the test)				Annex C
iv)	Viscosity	20 cSt, Max	16 cSt, Max	10 cSt, Max	10 cSt, Max	Using viscosity meter, <i>see</i> Sl No. (iv) of Table 2 of IS 1206 (Part 3)
v)	Pour point	Zero	Zero	Zero	Zero	Annex D
vi)	Sludge content (percent, v/v), Max	Original 0.5 Conditioned 1.0	Original 0.5 Conditioned 1.0	Original 0.25 Conditioned 0.5	Original 0.25 Conditioned 0.5	Annex E
vii)	Spreading coefficient	—	—	+3 minimum		Annex F

**Table 2 Fire Performance Requirements
(Clauses 3.3, G-1.1 and K-1.1)**

Sl No.	Performance	Protein	Film Forming Fluoro Protein	AFFF	Class A ¹⁾	Test Method
		3% and 6%	3% and 6%	3% and 6%	1% and 3%	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Film formation	No	Yes	Yes	No	Annex H
ii)	Expansion at $27 \pm 5^\circ\text{C}$	3, 6 to 10	3, 6 to 10	3, 6 to 10	4, Max	Annex J
iii)	25 % Drainage time at $27 \pm 5^\circ\text{C}$, Min	2 min, 30 s	2 min, 30 s	1 min, 30 s	1 min, 30 s	Annex J
iv)	Fire control(s)	120	90	60	Not for Class B Fire	Annex K
v)	Fire extinction(s)	180	120	90	—	Annex K
vi)	Burn back, Min	10	12	8	—	Annex K
vii)	Sealability	To pass the test	To pass the test	To pass the test	—	Annex K

¹⁾ For hydrocarbon fuel.

ANNEX A

[Table 1, Sl No. (i)]

METHOD FOR THE DETERMINATION OF pH VALUE

A-1 PREPARATION FOR AGED CONDITIONED SAMPLE

A-1.1 Condition a 500 ml thoroughly mixed sample of concentrate by heating it in an oven maintained at a constant temperature of $50 \pm 1^\circ\text{C}$ for 24 h. Allow it to return to $27 \pm 5^\circ\text{C}$ followed by cooling it in a refrigerator maintained at a constant temperature of $0 \pm 1^\circ\text{C}$ for 24 h and then allowing it to return to temperature of $27 \pm 5^\circ\text{C}$. This sample will be used for all those tests which require testing of aged conditioned sample.

A-2 PROCEDURE FOR pH DETERMINATION

A-2.1 Take 100 ml of a thoroughly mixed original that is unconditioned sample of Foam concentrate in a beaker and measure its pH value on a standard pH electrometer (see IS 4309) using glass electrode at a temperature of $27 \pm 5^\circ\text{C}$. Record the pH value to the nearest 0.1.

A-2.2 Repeat the experiment as in A-2.1 by taking 100 ml of conditioned sample taken from A-1.1 and record the pH value to the nearest 0.1.

ANNEX B

[Table 1, Sl No. (ii)]

METHOD FOR THE DETERMINATION OF SPECIFIC GRAVITY

B-1 PROCEDURE

B-1.1 Determine the specific gravity of 100 ml of the thoroughly mixed unconditioned sample of Foam concentrate of each type at a temperature of $27 \pm 5^\circ\text{C}$ using a Pyknometer or specific gravity bottle.

B-1.2 Determine the specific gravity of the 100 ml conditioned sample taken from A-1.1 in the same manner as in B-1.1.

B-1.3 Record the results to the nearest 0.01.

ANNEX C

[Table 1, Sl No. (iii)]

METHOD FOR THE DETERMINATION OF MISCIBILITY WITH WATER AND SYNTHETIC SEA WATER

C-1 SYNTHETIC SEA WATER

C-1.1 Prepare synthetic sea water by dissolving the following salts in one litre of distilled water:

Salt	Content, Percent, mm
Sodium chloride (NaCl)	2.50
Magnesium chloride ($\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$)	1.10
Sodium sulphate (Na_2SO_4)	0.40
Calcium chloride ($\text{CaCl}_2 \cdot \text{H}_2\text{O}$) dihydrate	0.16
Potable water	95.84

C-2 PREPARATION OF SAMPLE

C-2.1 Prepare a solution of 250 ml containing 6 percent of Type 3 Foam concentrate in 94 percent

of both fresh distilled and synthetic sea water as prepared in C-1.1 by volume at a temperature of $27 \pm 5^\circ\text{C}$.

C-2.2 Prepare a solution of 250 ml containing 12 percent of Type 6 Foam concentrate in 88 percent of fresh distilled and synthetic sea water prepared as in C-1.1 by volume.

C-3 PROCEDURE

C-3.1 The solutions as prepared in C-2.1 and C-2.2 shall be kept separately in stoppered graduated cylinder for 24 h. The solutions shall not show any stratification, precipitation and turbidity when examined visually at a temperature of $27 \pm 5^\circ\text{C}$.

ANNEX D

[Table 1, Sl No. (v)]

METHOD FOR THE DETERMINATION OF POUR POINT

D-1 APPARATUS

D-1.1 The apparatus shall be as shown in Fig. 1 and shall consist of the following:

- a) *Test Jar* — A test jar of clear glass, cylindrical form, flat bottom, approximately 30 to 35 mm inside diameter and 112 to 125 mm in height. An ordinary 100 ml sample bottle may be used, if it meets these requirements.
- b) *Thermometer* — A cloud and pour test thermometer which can read down to -10°C .
- c) *Cork* — To fit the test jar, bored centrally to take the test thermometer.
- d) *Jacket* — A jacket of glass or metal, water-tight, of cylindrical form, flat bottom about 112 mm in depth with inside diameter 10 to 12 mm greater than the outside diameter of the test jar.
- e) *Disc* — A disc of cork or felt, 6 mm thick and of the same diameter as the inside of the jacket.
- f) *Gasket* — A gasket about 5 mm thick, to fit snugly around the outside of the test jar and loosely inside the jacket. This gasket may be made of cork, felt or other suitable material, elastic enough to cling to the test jar and hard enough to hold its shape. The purpose of the ring gasket is to prevent the test jar from touching jacket.

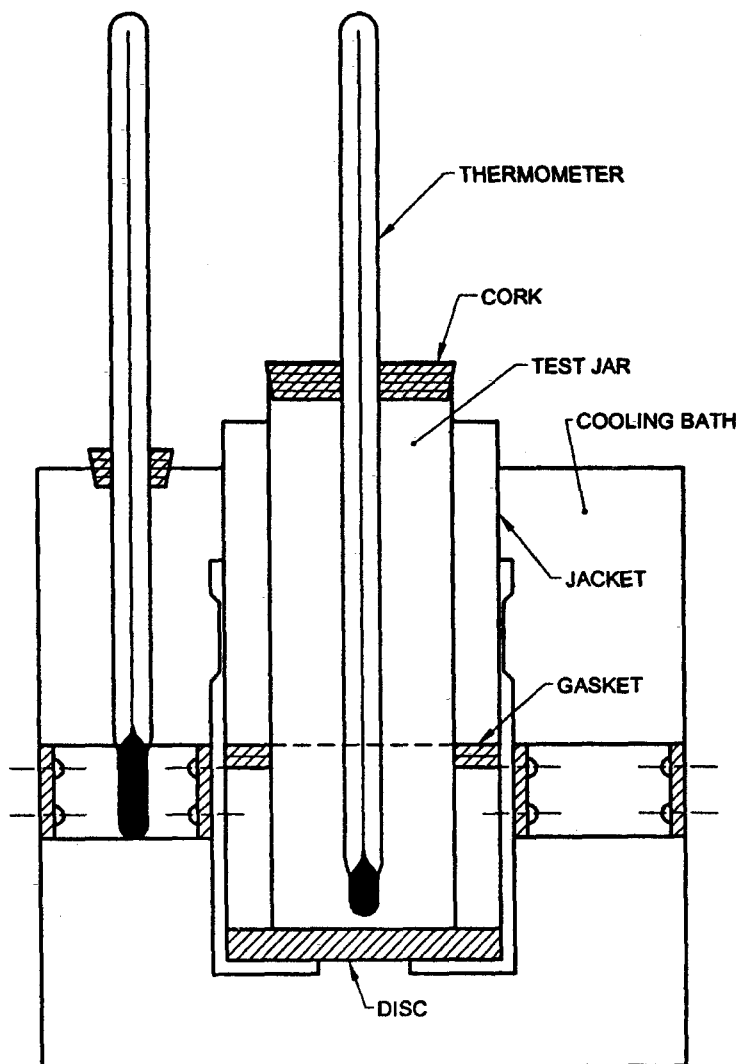


FIG. 1 APPARATUS FOR POUR TEST

- g) *Bath* — A cooling bath of suitable size and shape to obtain the required temperatures. The bath shall be provided with a support, suitable for holding the jacket firmly in a vertical position. The required bath temperature may be mentioned by refrigeration, if available, otherwise by suitable freezing mixtures.

D-2 PROCEDURE

D-2.1 The following procedure shall be followed:

- Pour the thoroughly shacked sample of foam compound into the test jar to a height of not less than 50 mm and not more than 56 mm. Mark the jar to indicate the proper level.
- Close the test jar tightly by the cork carrying the test thermometer in a vertical position in the centre of the jar with the thermometer

bulb immersed so that the beginning of the capillary shall be 3 mm below the surface of the sample.

- Fix the thermometer in vertical position.
- Place the disc in the jacket and insert the test jar with the ring gasket 25 mm above the bottom into the gasket.
- Maintain the temperature of the cooling bath at -5°C . Support the jacket containing the test jar, firmly in a vertical position in the cooling bath so that not more than 25 mm of the jacket projects out of the cooling medium. As soon as the temperature of the foam compound in the test jar goes down to 0°C , the jar shall be tilted and flow observed by holding the test jar in a horizontal position for 5 s as noted by stop-watch and foam compound shall flow freely.

ANNEX E

[Table 1, Sl No. (vi)]

METHOD FOR THE DETERMINATION OF SLUDGE CONTENT

E-1 PREPARATION

E-1.1 Shake/roll the container in which the Foam concentrate is stored after keeping upside down for 10 min till the sediment completely disperses in the liquid and then draw two samples out of it.

Sample A — 50/100 ml to be drawn in 50/100 ml cone shaped graduated clear glass centrifuge tube, which can read nearest to 0.1 ml, each type separately.

Sample B — 300 ml to be drawn in a 500 ml capacity stoppered conical flask, each type separately.

E-1.2 Take 100/50 ml conditioned sample and allow it to attain temperature of $27 \pm 5^{\circ}\text{C}$. Shake well by rotation till any sediment which may have settled has dispersed uniformly and pour into 100/50 centrifuge tube.

E-2 PROCEDURE

E-2.1 Centrifuge the Sample A for 30 min immediately

after drawing the sample. Pour out the liquid gently after centrifuging. Dry the centrifuge tube containing the sludge in an oven at 60°C for 1 h. Then keep it at ambient temperature for 30 min and take the weight of centrifuge tube along with sludge. Calculate the sludge content as follows:

$$\text{Sludge content, percent} = \frac{\text{Weigh of sludge content of the sample}}{\text{Volume of foam (50/100 ml)} \times \text{sp. gr.}} \times 100$$

E-2.2 Any standard centrifuge may be used so long as its rev/min conforms to the following requirements:

$$\text{rev/min} = 423\sqrt{RCF/d}$$

where

RCF = relative centrifugal force shall be between 500 and 600, and

d = diameter in cm between the tips of the opposite tube while in rotating position.

ANNEX F

[Table 1, Sl No. (vii)]

**DETERMINATION OF SURFACE TENSION, INTERFACIAL
TENSION AND SPREADING COEFFICIENT
(For AFFF Foam Concentrate 3 and 6 Percent Type)**

F-1 MATERIALS

F-1.1 Solution of Foam concentrate, at the recommended concentration for use in freshly made distilled water complying having surface tension not less than 70 m N/m.

NOTE — The solution may be made up in a 100 ml volumetric flask using a pipette to measure the foam concentrate.

F-1.2 Cyclohexane, of purity not less than 99 percent (AR grade) for interfacial tension and spreading coefficient only.

F-2 PROCEDURE FOR DETERMINING SURFACE TENSION

Determine the surface tension of the solution (F-1.1) at a temperature of $27 \pm 5^\circ\text{C}$ using the ring method.

F-2.1 Apparatus

The following apparatus is required:

- a) Du Nouy precision tensiometer,
- b) Platinum ring of 4 or 6 cm circumference, and
- c) Sample container (glass) 6 cm in diameter.

F-2.2 Sample

A solution of 10 ml of 3 ± 0.05 percent of Type 3 AFFF and 97 percent of distilled water by volume and/or 6 ± 0.1 percent of Type 6 AFFF and 94 percent of distilled water by volume.

F-2.3 Procedure

Calibrate the tensiometer. Clean the glassware with chromic sulphuric acid rinsing in distilled water. The platinum ring shall be rinsed thoroughly in a solvent and distilled water and then dry it in the oxidizing portion of the gas flame. Check the level of the tensiometer and insert the platinum ring in the sample of AFFF solution contained in glass sample container. Take the measurement. Set the dial and the vernier at zero portion. Raise the sample platform until the ring is first submerged. Lower the platform slowly, at the same time applying torsion to the wire by means of dial adjusting screw so that the ring system remains constantly at its zero position. As the breaking point is approaching nearer and nearer, adjustments are made slowly. Record the dial reading when the ring detaches from the surface and express it in dynes/cm².

F-3 PROCEDURE FOR DETERMINATION OF INTERFACIAL TENSION

After measuring the surface tension in accordance with F-2, introduce a layer of cyclohexane (F-1.2) at $27 \pm 5^\circ\text{C}$ onto the foam solution (F-1.1), being careful to avoid contact between the ring and the cyclohexane. Wait 6 ± 1 min and then measure the interfacial tension as under.

F-3.1 Apparatus

Same as in F-2.1.

F-3.2 Sample

Same as in F-2.2.

F-3.3 Procedure

The interfacial tension is determined in the same manner as the surface tension with the following modifications:

- a) Use fresh solutions and freshly cleaned platinum ring for each determination.
- b) Always move the ring from the aqueous side of the interface through to the non-aqueous side liquid.
- c) First place the aqueous solutions in the sample vessel and immerse the ring therein. Carefully pour the cyclohexane on top of the aqueous solution to form the two-layer systems. Contact between the oil and the platinum ring should be avoided during this operation. After allowing sufficient time, make the measurement in the same manner as that used for measuring surface tension.

F-4 SPREADING COEFFICIENT

Calculate the spreading coefficient between the solution (F-1.1) and cyclohexane (F-1.2) from the equation:

$$S = \gamma_c - \gamma_f - \gamma_i$$

where

- S = spreading coefficient, in dynes/cm;
 γ_c = surface tension of the cyclohexane, in dynes/cm;
 γ_f = surface tension of the foam solution, in dynes/cm; and

γ_i = interfacial tension between the foam solution and cyclohexane, in dynes/cm.

The spreading coefficient shall be determined with reference to cyclohexane in accordance with the following relationship:

$$Sa/b = rb - ra - r_i$$

where

Sa/b = spreading coefficient,

rb = standard value of surfaces tensions of collector,

ra = surface tension of premixed AFFF solution as determined in F-2, and

r_i = interfacial tension between premixed AFFF and cyclohexane as determined in F-3.

F-5 DIGITAL TENSIO METER

Make sure that the digital densitometer is calibrated. Introduce the solution of AFFF in to device. Ensure zero reading in the monitor, start operation as mentioned above and finally note the reading from the monitor in dynes/cm.

ANNEX G

(Clause 3.3, and Annex H)

METHOD OF GENERATING FOAM

G-1 FOAM MAKING NOZZLE

G-1.1 A foam making nozzle having a water foam solution discharge capacity 7.5 l/min at 7 kgf/cm² shall be used for producing foam and checking the performance requirement laid down in Table 2. The details and the dimensions of the nozzle are given in Fig. 2.

G-2 ARRANGEMENT FOR GENERATING FOAM

G-2.1 The following apparatus shall be used and assembled as shown in Fig. 3:

- a) *100-litre Capacity Pressure Reservoir* — Made of stainless steel or mild steel sheet and tested to withstand an internal pressure of 25 kgf/cm². It shall have a filling orifice of not less than 150 mm diameter with an airtight cap and other arrangements as given in Fig. 3,

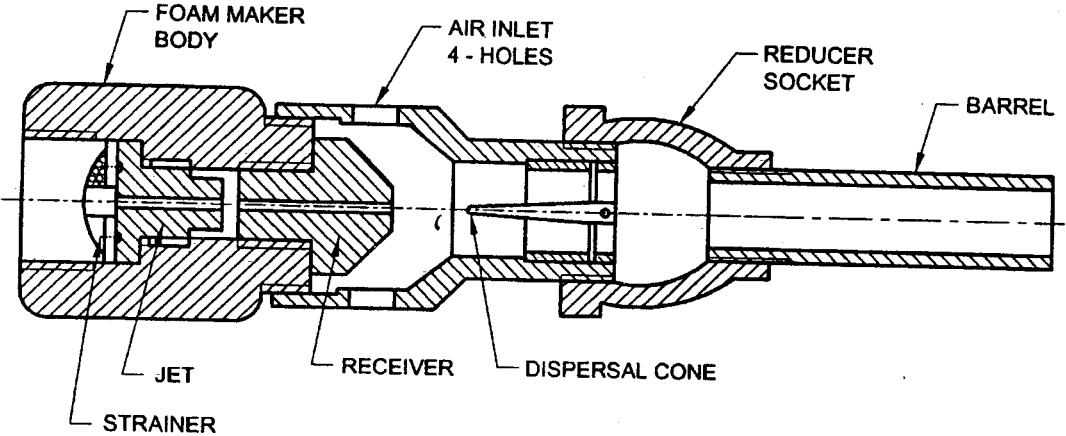
- b) Adjustable stand,
- c) Nozzle (*see* Fig. 2), and
- d) Air compressor.

G-3 CALIBRATION

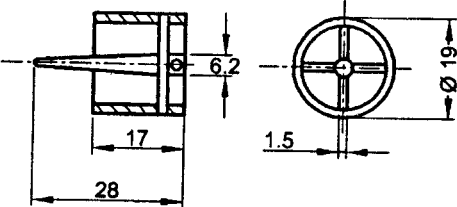
G-3.1 The pressure gauges and nozzle shall be calibrated before use when new and thereafter once every six months according to the standard procedure.

G-4 FOAM GENERATION

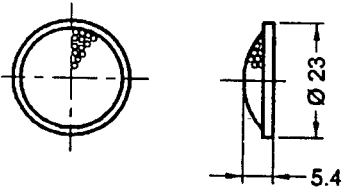
G-4.1 The equipment shall be arranged as shown in Fig. 3. The reservoir should be filled with 90 l of 3 percent or 6 percent premixed solution of foam compound and potable water in desired proportions. The cap shall be tightened. A pressure of 8 kgf/cm² shall be built up with help of air compressor. The discharge valve is then opened and the pressure is adjusted so as to give a pressure of 7 kgf/cm² at the inlet of the nozzle.



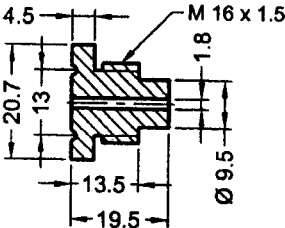
2A ASSEMBLY



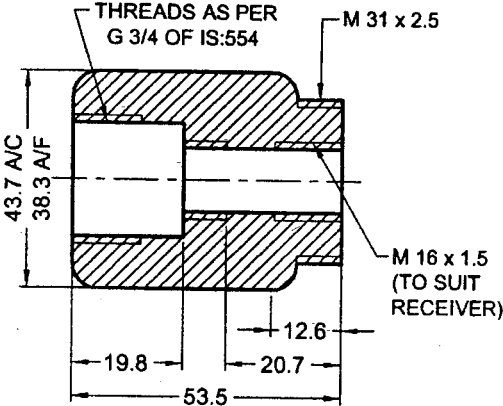
2B DISPERSED CONE



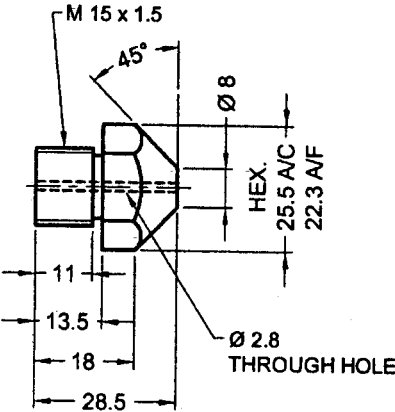
2C STRAINER



2D JET



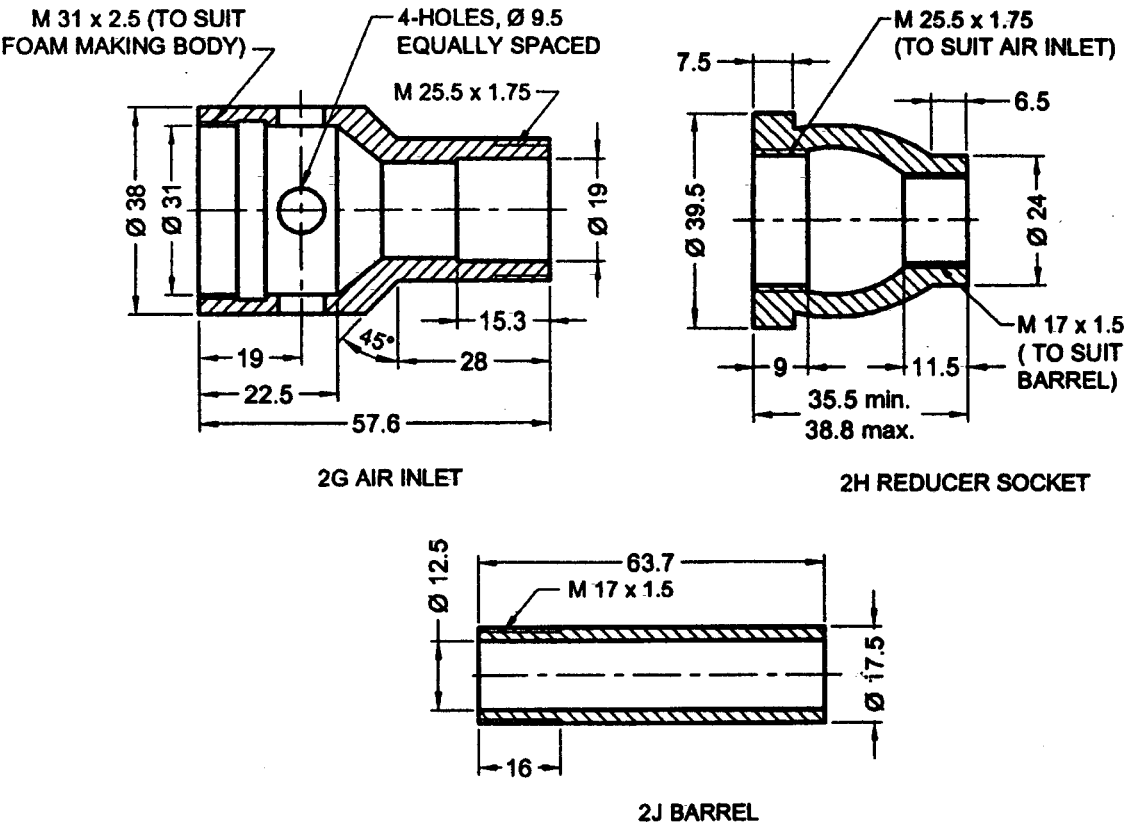
2E FOAM MAKING BODY



2F RECEIVER

All dimensions in millimetres.

FIG. 2 FOAM MAKING NOZZLE OF CAPACITY 7.5 l/min — Continued



All dimensions in millimetres.

FIG. 2 FOAM MAKING NOZZLE OF CAPACITY 7.5 l/min

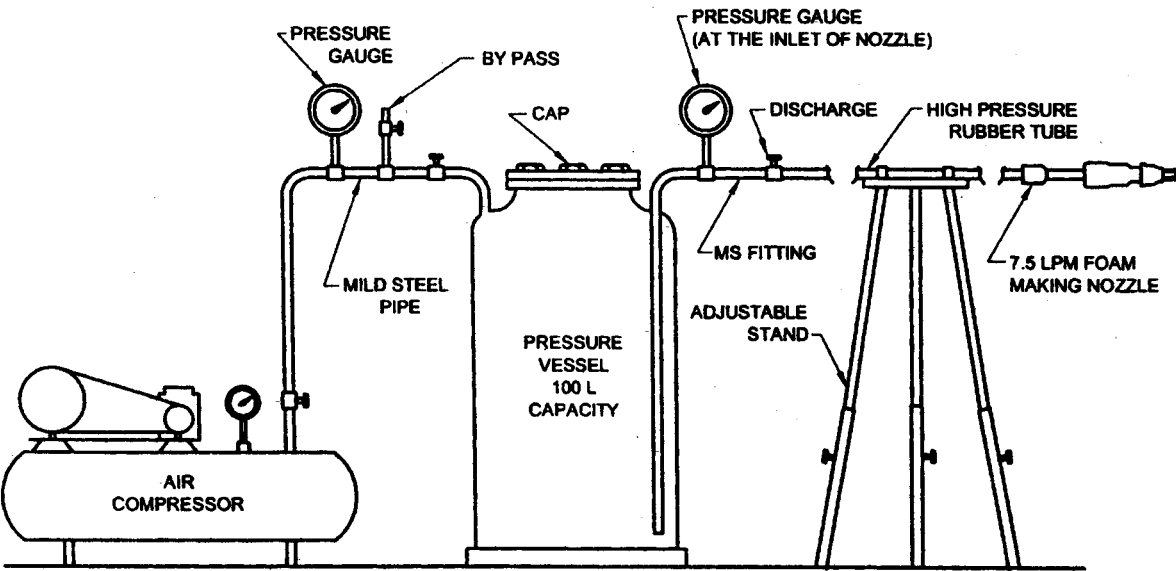


FIG. 3 ARRANGEMENT OF FOAM GENERATING EQUIPMENT

ANNEX H

[Table 2, Sl No. (i)]

FILM FORMATION TEST

(Only for AFFF Type 3 and 6 Percent Foam Concentrates)

H-1 EQUIPMENT

- Mild steel sheet fire tray having dimensions of 60 cm × 60 cm and height 15 cm;
- Cylindrical shaped drum made of stainless steel wire mesh of size 180 µm IS sieve having height of 45 cm, and internal diameter 20 cm. The drum is closed at lower end with mild steel sheet and open at upper end;
- A suitable tong to lower and raise the drum in the tray during test; and
- The nozzle and the arrangements as per details given in Annex G.

H-2 PROCEDURE

H-2.1 Pour water in the tray, up to a height of 5 cm. Pour 2 l of commercial heptane over the water surface. Generate the foam and operate the nozzle at 7 kg/cm²

and fill the tray by operation of the nozzle gently with the help of a suitable goose neck. Immediately after stoppage of foam application, place the cylindrical strainer drum with open end up on the tray. Wait for 3 min. Now lower a lighted torch (lighted with Heptane/alcohol through the open end of the strainer and bring it near but not touching) the liquid surface; care shall be exercised to ensure that burning alcohol/Heptane does not drip down from the torch over the film surface. The surface shall not ignite.

Now the burning torch should be very lightly touched to the liquid surface. The surface shall not ignite. Keep repeating the test at intervals of 1 min from stopping the foam application. The film shall be held for minimum 15 min.

NOTE — In all the above tests, intermittent self-extinguishing 'Walk Over'/'Flash' of flame is ignored. However, if sustained burning occurs, and then the film is considered weak/absent.

ANNEX J

[Table 2, Sl No. (ii) and (iii)]

DETERMINATION OF EXPANSION AND DRAINAGE TIME

J-1 APPARATUS

J-1.1 Plastics or glass collecting vessel, of known volume of approx. 1.6 l ± 1 percent, equipped with a bottom discharge facility, as shown in Fig. 4.

J-1.2 Foam collector, for expansion and drainage measurement, as shown in Fig. 4. Stainless steel, aluminum, brass and plastics are suitable materials for the collection surface.

J-1.3 Foam-making nozzle (see Fig. 2 and 3), which when tested with water, has a flow rate of 7.5 l/min at a nozzle pressure of 7 kg/cm².

J-1.4 Foam solution vessel, connected to the nozzle.

J-2 TEMPERATURE CONDITIONS

J-2.1 Carry out the tests under the temperatures of foam solution 27 ± 5°C.

J-3 PROCEDURE FOR EXPANSION

J-3.1 Check that the pipework and hose from the foam solution tank (J-1.4) to the nozzle (J-1.3) is completely full of solution. Set up the nozzle horizontally, directly in front of the foam collector (J-1.2) with the front of the nozzle 3 ± 0.3 m from the top edge of the collector. Wet the collecting vessel (J-1.1) internally and weigh it (m_1). Set up the foam-making nozzle and adjust the nozzle pressure 7 kg/cm². Discharge foam and adjust the height of the nozzle so that the discharge strikes the collector centrally. Keep the nozzle horizontal. Stop foam discharge and rinse all the foam from the collector. Check that the foam solution tank is full. Start discharging foam and, after 30 ± 5 s to allow the discharge to stabilize, place the collecting vessel, with the discharge outlet closed, below the collector. Immediately after pouring foam into pan, start stop watch and as soon as the vessel is full, remove it from

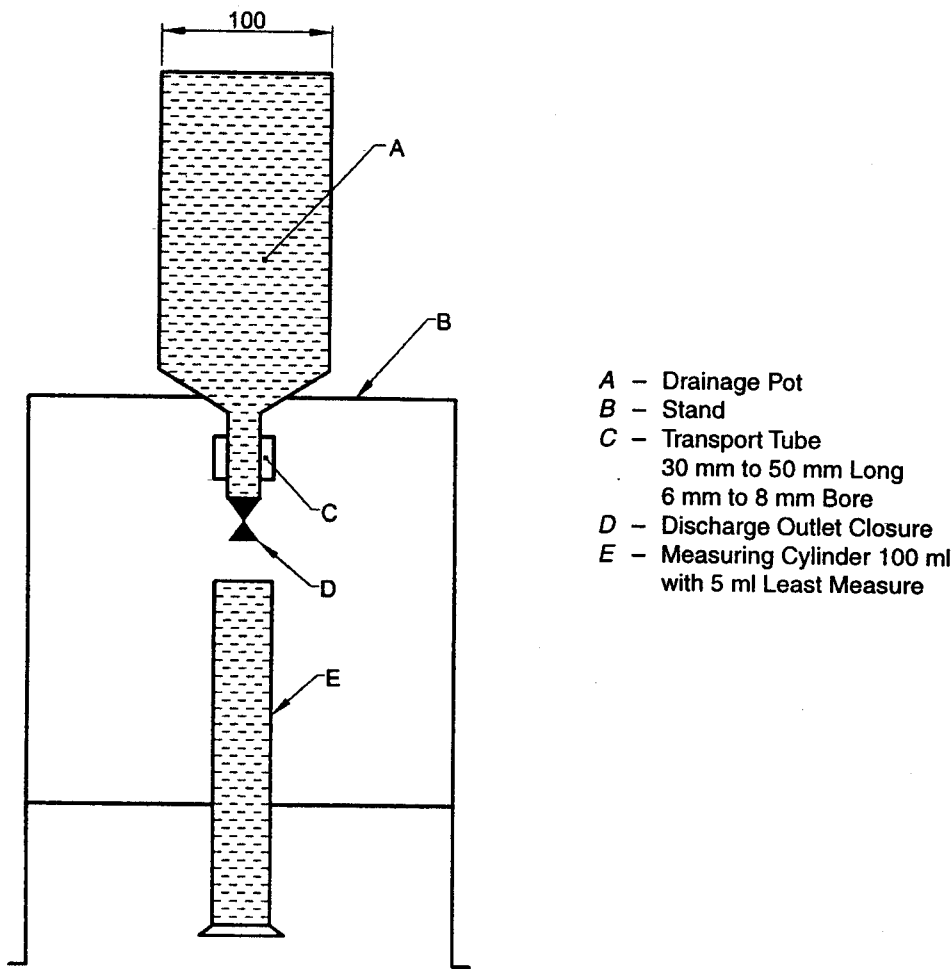


FIG. 4 COLLECTING VESSEL FOR DETERMINATION OF EXPANSION AND DRAINAGE TIME

the collector, strike off the foam surface level with the rim. Weigh the full vessel (m_2).

Calculate the expansion E from the equation:

$$E = \frac{V}{m_2 - m_1}$$

where

- V = volume, in litres, of the collecting vessel;
- m_1 = mass, in kg, of the empty vessel; and
- m_2 = mass in kg, of foam filled vessel.

Assume that the density of the foam solution is 1.0 kg/l.

Open the drainage facility (see J-1.1) and collect the foam solution in the measuring cylinder to measure the 25 percent drainage time. Adjust the drainage facility such that the drained foam solution may flow out whilst preventing the passage of foam.

NOTE — This may be achieved by controlling the level of the liquid/foam interface in the plastic tube at the outlet.

J-4 PROCEDURE FOR CALCULATING 25 PERCENT DRAINAGE TIME

J-4.1 25 percent drainage volume is calculated from the foam expansion and drainage pan volume. The drainage time is measured from commencing to fill the pan with foam up to the 25 percent drainage value. The example of calculating 25 percent drainage is given below:

- Volume of drainage pan : 1 600 ml
- Expansion of foam : 8

$$25 \text{ percent drainage time volume} = \frac{1\,600}{4 \times 8} = 50 \text{ ml}$$

- a) Immediately after pouring foam into pan start the stop watch,
- b) Measure expansion, and
- c) Start noting of volume of drained water from 20 ml to 80 ml and prepare a graph time *versus* volume of drained liquid. Time in seconds for 50 ml drained liquid is the 25 percent drainage time in the above example.

ANNEX K

[Clause 3.3; and Table 2, Sl No. (iv), (v), (vi) and (vii)]

DETERMINATION OF TEST FIRE PERFORMANCE

K-1 GENERAL CONDITIONS

K-1.1 A test is successful only if the appropriate requirements of this clause are met and performance is met as per Table 2.

K-1.1.1 Carry out one test with potable water and the other with the synthetic sea water of C-1.1. If both are successful or if both are not successful, terminate the test series. If only one of the tests is not successful, repeat that test. If this repeat test is successful, carry out a second repeat test, otherwise terminate the test series. The concentrate complies with this clause:

- a) if the first two tests are successful, or
- b) if one of the first two tests and both repeat tests are successful.

K-1.2 Temperature and Wind Speed

Carry out the tests under the following conditions:

Foam solution temperature : $27 \pm 5^\circ\text{C}$

Maximum wind speed : 3 m/s in the proximity of the test pan

NOTE — If necessary, some form of wind-screen may be used.

K-1.3 Records

During the first test, record the following:

- a) Indoor or outdoor test,
- b) Foam-solution temperature,
- c) Wind speed,
- d) Control time,
- e) Extinction time, and
- f) 25 percent burn back time (where appropriate).

For quality control purposes, it is recommended that 90 percent control times and complete extinction are recorded. Control times may be determined visually.

K-1.4 Foam Solution

Prepare a foam solution following the recommendations from the supplier for the concentration, maximum premix time, compatibility with the test equipment, avoidance of contamination by other types of foam, etc.

Use potable water to prepare up the foam solution and also make a foam solution using simulated sea water made up by dissolving the components as per synthetic sea water composition given at C-1.1.

Fill up the solution in the foam tank, 100 litres capacity and arrange equipment as given in Fig. 4.

K-1.5 Fuel

Typical fuels meeting this specification are *n*-heptane.

K-2 GENTLE APPLICATION

K-2.1 Method for the Determination of Fire Extinguishing Properties

K-2.1.1 Equipment

Circular mild steel tray having base area of 2.5 m^2 with height 0.6 m.

Adjustable stand to hold the nozzle firmly.

Torch to ignite *n*-heptane.

K-2.1.2 Procedure

Pour 225 l of potable water in the tank so that the height of the water in tank is about 10 cm. Pour 50 l of *n*-heptane within 30 s into the tank over the water surface. Position the test nozzle at 7 kgf/cm^2 pressure at such a level and direction that the foam stream, when discharged inside across the tank, strikes it just above the water/*n*-heptane level (preferably 10 cm). Nozzle end should not extend over any part of the test pan.

K-2.2 Fire Test

K-2.2.1 Ignite the *n*-heptane within 30 s of pouring and allow it to burn for 30 s. Generate foam and direct the stream at the back of the tank just above the water/fuel surface for 180 s. After 180 s stop the foam application. Record the time of fire control and complete extinction.

NOTES

- 1 Premix solution under pressure should be used within 45 min.
- 2 Before fire test the fire tank should be cleaned properly free from rust and without any projection or dents.
- 3 Potable water should be used in the fire pan and temperature should be $27 \pm 5^\circ\text{C}$.
- 4 The technical persons performing this test should have to be protected with fire proof suits, shoes, gloves and helmet with face shield.

K-2.3 Burn Back Test

K-2.3.1 *Burn Back Pot*, made of steel with nominal thickness 1.5 mm, dia $120 \pm 5 \text{ mm}$, and depth $100 \pm 2 \text{ mm}$.

K-2.3.2 *Procedure*, a suitable arrangement to hold this pot and place it in the fire test tank.

- a) Fill up approx. one litre fuel in the burn back po .

- b) 60 s after complete extinction of fire in fire tank place burn back tray at approx. centre of tank in such a way the upper surface of foam and edges of burn back tank are about the same level. In any case foam should not enter in the burn back pot.
- c) Ignite the pot with the help of a lighted torch.

Allow the fuel to burn in draught free still air condition and ensure that flames are vertical. Watch by visual observation 25 percent fire test tank is under fire. This time is recorded as burn back time for a foam blanket which is a indirect measure of thermal stability as well as sealability of the foam blanket.

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Amendments Issued Since Publication

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AMENDMENT NO. 1 NOVEMBER 2008
TO
IS 4989 : 2006 FOAM CONCENTRATE FOR PRODUCING
MECHANICAL FOAM FOR FIRE FIGHTING —
SPECIFICATION

(Third Revision)

(Page 1, clause 3.2, line 4) — Delete ‘amber colour’.

(Page 2, clause 5.3) — Add the following:

‘5.4 Range of storage temperature shall be 0°C to 50°C for prolonged storage.’

[Page 2, clause 6.1, Sl No. (j)] — Delete.

(Page 2, clause 7, last line) — Substitute the following for the existing:

‘Density/specific gravity 0.65 to 0.75 at $27 \pm 5^{\circ}\text{C}$ ’.

[Page 3, Table 1, Sl No. (iv), col 7] — Substitute the following for the existing:

‘Using viscosity meter of size No. 3 for AFFF and Class A foam and size No. 4 for other foams as given in Table 2 of IS 1206 (Part 3)’.

[Page 3, Table 1, Sl No. (vi)] — Substitute ‘Sludge content (percent, w/w), Max’ for ‘Sludge content (percent, v/v), Max’.

[Page 3, Table 2, Sl No. (ii), col 3 and 4] — Substitute ‘6 to 10’ for ‘3, 6 to 10’.

[Page 3, Table 2, Sl No. (ii), col 5] — Substitute ‘6 to 12’ for ‘3, 6 to 10’.

[Page 3, Table 2, Sl No. (iii), col 4.] — Substitute ‘1 min 30 s’ for ‘2 min 30 s’.

(Page 4, Annex C, clause C-1.1, table, last line) — Substitute ‘Distilled water’ for ‘Potable water’.

(Page 4, Annex C, clause C-1.1, table, col heading) — Substitute ‘m/m’ for ‘mm’.

Amend No. 1 to IS 4989 : 2006

(Page 4, Annex C, clause **C-2.2**) — Substitute the following for the existing:

‘Prepare a solution of 250 ml containing 2 percent of Type 1 foam concentrate in 98 percent distilled and synthetic sea water.’

(Page 5, Fig. 1, Captions) — Substitute ‘APPARATUS FOR POUR POINT TEST’ for ‘APPARATUS FOR POUR TEST’.

(Page 7, Annex F, clause **F-2.3**, last line) — Substitute ‘dynes/cm’ for ‘dynes/cm²’.

(Page 8, Annex F, clause **F-4**, para 5) — Delete ‘The spreading coefficient shall be determined with as determined in F.3’.

(Page 11, Annex H, clause **H-2.1**, line 4) — Insert ‘for 40 sec’ after ‘of the nozzle gently’.

(Page 13, Annex K, clause **K-1.4**, para 3, line 2) — Substitute ‘Fig. 3’ for ‘Fig. 4’.

(CED 22)